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# Sampling by mantle plumes : the legacy of the plume source.

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Abstract

Plumes in the Earth's mantle are considered to be at the origin of intraplate volcanism (or hotspots). They continue to fascinate the scientific community by the heterogeneity of the material they sample on the surface of our planet. To characterize what part of the mantle is sampled by plumes, we have developed a laboratory model for laminar thermal plumes at high Prandtl number, in a fluid whose viscosity depends strongly on the temperature. This study describes the precise phenomenology of the plume and proposes scaling laws for the speed and temperature of the conduit of the plume. We show a strong dependence of these features of the plume with the Rayleigh number and viscosity ratio. Our visualization technique allows for the simultaneous non-intrusive measurements of the temperature, deformation and velocity fields. By calculating numerically the advection of passive markers through the experimental velocity field, we found that (1) the hot center of the plume conduit only consists of fluid which has passed through the thermal boundary layer ("TBL") at the bottom of the tank from which the plume was issued. Moreover, as material is stretched by velocity gradients, it is also in the thermal boundary layer that most of the material stretching occurs (2). The fluid is then transported in the conduit without lateral mixing, and further stretched vertically by the lateral velocity gradients.

Since it is only the hot upwelling plume center which melts and therefore is sampled by volcanic activity, (1) implies that the plume geochemical signature is representative of the material located in the deep TBL of the mantle from which the plume is issued. On the other hand, (2) implies that filaments, pancakes, and concentric or bimodal zonation of the plume at the surface all result from different distributions of the heterogeneities in the plume source, filaments being the most generic case. Finally, we apply the scaling laws to the case of Hawaii.